FAIRCHILD SEMICONDUCTOR™

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# MM74HC165
# Parallel-in/Serial-out 8-Bit Shift Register

## General Description

The MM74HC165 high speed PARALLEL-IN/SERIAL-OUT SHIFT REGISTER utilizes advanced silicon-gate CMOS technology. It has the low power consumption and high noise immunity of standard CMOS integrated circuits, along with the ability to drive 10 LS-TTL loads.

This 8-bit serial shift register shifts data from $Q_A$ to $Q_H$ when clocked. Parallel inputs to each stage are enabled by a low level at the SHIFT/LOAD input. Also included is a gated CLOCK input and a complementary output from the eighth bit.

Clocking is accomplished through a 2-input NOR gate permitting one input to be used as a CLOCK INHIBIT function. Holding either of the CLOCK inputs high inhibits clocking, and holding either CLOCK input low with the SHIFT/LOAD input high enables the other CLOCK input. Data transfer occurs on the positive going edge of the clock. Parallel loading is inhibited as long as the SHIFT/LOAD input is HIGH. When taken LOW, data at the parallel inputs is loaded directly into the register independent of the state of the clock.

The 74HC logic family is functionally as well as pin-out compatible with the standard 74LS logic family. All inputs are protected from damage due to static discharge by internal diode clamps to $V_{CC}$ and ground.

## Features

- Typical propagation delay: 20 ns (clock to Q)
- Wide operating supply voltage range: 2–6V
- Low input current: 1 μA maximum
- Low quiescent supply current: 80 μA maximum (74HC Series)
- Fanout of 10 LS-TTL loads

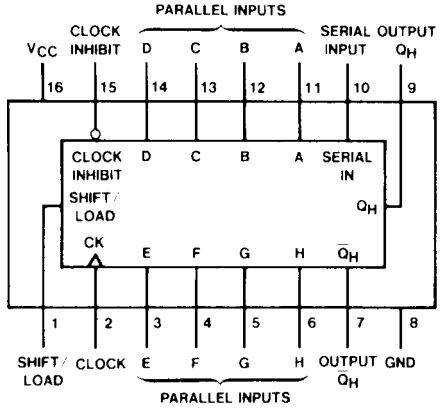
## Ordering Code:

| Order Number | Package Number | Package Description |
|---|---|---|
| MM74HC165M | M16A | 16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow |
| MM74HC165SJ | M16D | 16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide |
| MM74HC165MTC | MTC16 | 16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide |
| MM74HC165 | N16E | 16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide |

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

## Connection Diagram

**Pin Assignments for DIP, SOIC, SOP and TSSOP**




**Top View**

## Function Table

| Inputs | | | | | Internal Outputs | | Output |
|---|---|---|---|---|---|---|---|
| Shift/ Load | Clock Inhibit | Clock | Serial | Parallel A. . .H | $Q_A$ | $Q_B$ | $Q_H$ |
| L | X | X | X | a. . .h | a | b | h |
| H | L | L | X | X | $Q_{A0}$ | $Q_{B0}$ | $Q_{H0}$ |
| H | L | ↑ | H | X | H | $Q_{AN}$ | $Q_{GN}$ |
| H | L | ↑ | L | X | L | $Q_{AN}$ | $Q_{GN}$ |
| H | H | X | X | X | $Q_{A0}$ | $Q_{B0}$ | $Q_{H0}$ |

H = HIGH Level (steady state), L = LOW Level (steady state)
X = Irrelevant (any input, including transitions)
↑ = Transition from LOW-to-HIGH level
$Q_{A0}$, $Q_{B0}$, $Q_{H0}$ = The level of $Q_A$, $Q_B$, or $Q_H$, respectively, before the indicated steady-state input conditions were established.
$Q_{AN}$, $Q_{GN}$ = The level of $Q_A$ or $Q_G$ before the most recent ↑ transition of the clock; indicates a one-bit shift.

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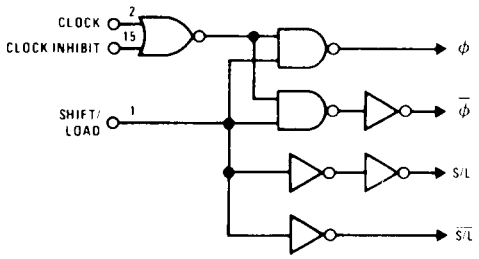
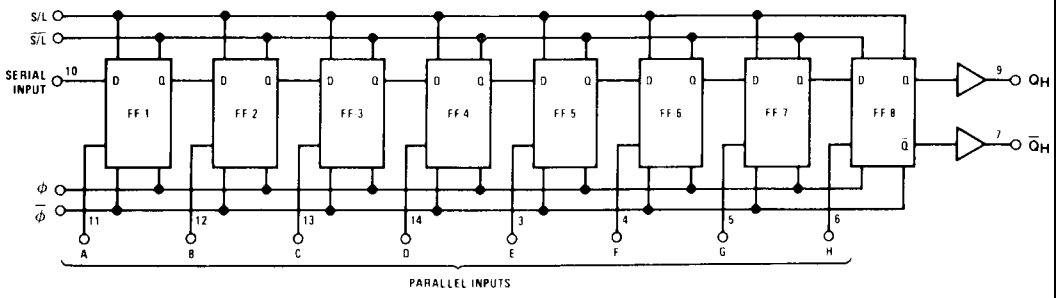
## Logic Diagrams



## Absolute Maximum Ratings (Note 1)

(Note 2)

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | −0.5 to +7.0V |
| DC Input Voltage ($V_{IN}$) | −1.5 to $V_{CC}$ +1.5V |
| DC Output Voltage ($V_{OUT}$) | −0.5 to $V_{CC}$ +0.5V |
| Clamp Diode Current ($I_{IK}$, $I_{OK}$) | ±20 mA |
| DC Output Current, per pin ($I_{OUT}$) | ±25 mA |
| DC $V_{CC}$ or GND Current, per pin ($I_{CC}$) | ±50 mA |
| Storage Temperature Range ($T_{STG}$) | −65°C to +150°C |
| Power Dissipation ($P_D$) | |
| (Note 3) | 600 mW |
| S.O. Package only | 500 mW |
| Lead Temperature ($T_L$) | |
| (Soldering 10 seconds) | 260°C |

## Recommended Operating Conditions

| | Min | Max | Units |
|---|---|---|---|
| Supply Voltage ($V_{CC}$) | 2 | 6 | V |
| DC Input or Output Voltage | | | |
| ($V_{IN}$, $V_{OUT}$) | 0 | $V_{CC}$ | V |
| Operating Temperature Range ($T_A$) | −40 | +85 | °C |
| Input Rise or Fall Times | | | |
| ($t_r$, $t_f$) $V_{CC}$ = 2.0V | | 1000 | ns |
| $V_{CC}$ = 4.5V | | 500 | ns |
| $V_{CC}$ = 6.0V | | 400 | ns |

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C.

## DC Electrical Characteristics (Note 4)

| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A$ = 25°C | $T_A$ = −40 to 85°C | $T_A$ = −55 to 125°C | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $V_{IH}$ | Minimum HIGH Level Input Voltage | | 2.0V | | 1.5 | 1.5 | 1.5 | V |
| | | | 4.5V | | 3.15 | 3.15 | 3.15 | V |
| | | | 6.0V | | 4.2 | 4.2 | 4.2 | V |
| $V_{IL}$ | Maximum LOW Level Input Voltage | | 2.0V | | 0.5 | 0.5 | 0.5 | V |
| | | | 4.5V | | 1.35 | 1.35 | 1.35 | V |
| | | | 6.0V | | 1.8 | 1.8 | 1.8 | V |
| $V_{OH}$ | Minimum HIGH Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \le 20$ μA | 2.0V | 2.0 | 1.9 | 1.9 | 1.9 | V |
| | | | 4.5V | 4.5 | 4.4 | 4.4 | 4.4 | V |
| | | | 6.0V | 6.0 | 5.9 | 5.9 | 5.9 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \le 4.0$ mA | 4.5V | 4.2 | 3.98 | 3.84 | 3.7 | V |
| | | $\|I_{OUT}\| \le 5.2$ mA | 6.0V | 5.7 | 5.48 | 5.34 | 5.2 | V |
| $V_{OL}$ | Maximum LOW Level Output Voltage | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \le 20$ μA | 2.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 4.5V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | | 6.0V | 0 | 0.1 | 0.1 | 0.1 | V |
| | | $V_{IN}$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $\|I_{OUT}\| \le 4.0$ mA | 4.5V | 0.2 | 0.26 | 0.33 | 0.4 | V |
| | | $\|I_{OUT}\| \le 5.2$ mA | 6.0V | 0.2 | 0.26 | 0.33 | 0.4 | V |
| $I_{IN}$ | Maximum Input Current | $V_{IN}$ = $V_{CC}$ or GND | 6.0V | | ±0.1 | ±1.0 | ±1.0 | μA |
| | | $V_{CC}$ = 2–6V | | | | | | |
| $I_{CC}$ | Maximum Quiescent Supply Current | $V_{IN}$ = $V_{CC}$ or GND | 6.0V | | 8.0 | 80 | 160 | μA |
| | | $I_{OUT}$ = 0 μA | | | | | | |
| | | $V_{CC}$ = 2–6V | | | | | | |

**Note 4:** For a power supply of 5V ±10% the worst case output voltages ($V_{OH}$, and $V_{OL}$) occur for HC at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case $V_{IH}$ and $V_{IL}$ occur at $V_{CC}$ = 5.5V and 4.5V respectively. (The $V_{IH}$ value at 5.5V is 3.85V.) The worst case leakage current ($I_{IN}$, $I_{CC}$, and $I_{OZ}$) occur for CMOS at the higher voltage and so the 6.0V values should be used.

## AC Electrical Characteristics

$V_{CC}$ = 5V, $T_A$ = 25°C, $C_L$ = 15 pF, $t_r = t_f$ = 6 ns

| Symbol | Parameter | Conditions | Typ | Guaranteed Limit | Units |
|---|---|---|---|---|---|
| $f_{MAX}$ | Maximum Operating Frequency | | 50 | 30 | MHz |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay H to $Q_H$ or $\overline{Q}_H$ | | 15 | 25 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay Serial Shift/Parallel Load to $Q_H$ | | 13 | 25 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation Delay Clock to Output | | 15 | 25 | ns |
| $t_S$ | Minimum Setup Time Serial Input to Clock, Parallel or Data to Shift/Load | | 10 | 20 | ns |
| $t_S$ | Minimum Setup Time Shift/Load to Clock | | 11 | 20 | ns |
| $t_S$ | Minimum Setup Time Clock Inhibit to Clock | | 10 | 20 | ns |
| $t_H$ | Minimum Hold Time Serial Input to Clock or Parallel Data to Shift/Load | | | 0 | ns |
| $t_W$ | Minimum Pulse Width Clock | | | 16 | ns |

## AC Electrical Characteristics

$C_L$ = 50 pF, $t_r = t_f$ = 6 ns (unless otherwise specified)

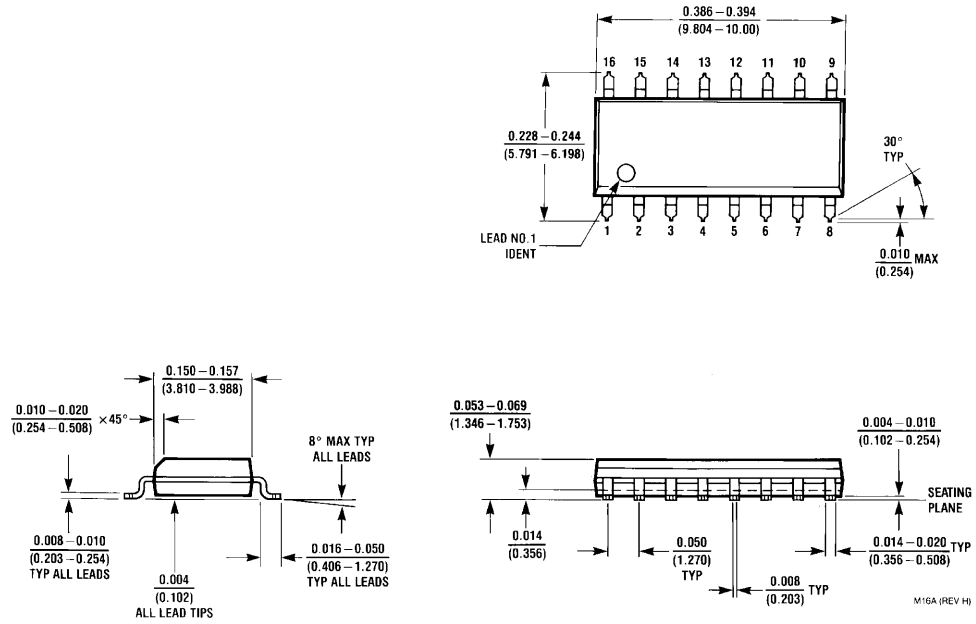
| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A$ = 25°C | $T_A$ = −40 to 85°C | $T_A$ = −55 to 125°C | Units |
|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | |
| $f_{MAX}$ | Maximum Operating | | 2.0V | 10 | 5 | 4 | 4 | MHz |
| | Frequency | | 4.5V | 45 | 27 | 21 | 18 | MHz |
| | | | 6.0V | 50 | 32 | 25 | 21 | MHz |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 70 | 150 | 189 | 225 | ns |
| | Delay H to $Q_H$ or $\overline{Q}_H$ | | 4.5V | 21 | 30 | 38 | 45 | ns |
| | | | 6.0V | 18 | 26 | 33 | 39 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 70 | 175 | 220 | 260 | ns |
| | Delay Serial Shift/ | | 4.5V | 21 | 35 | 44 | 52 | ns |
| | Parallel Load to $Q_H$ | | 6.0V | 18 | 30 | 37 | 44 | ns |
| $t_{PHL}$, $t_{PLH}$ | Maximum Propagation | | 2.0V | 70 | 150 | 189 | 225 | ns |
| | Delay Clock to Output | | 4.5V | 21 | 30 | 38 | 45 | ns |
| | | | 6.0V | 18 | 26 | 33 | 39 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | 35 | 100 | 125 | 150 | ns |
| | Serial Input to Clock, | | 4.5V | 11 | 20 | 25 | 30 | ns |
| | or Parallel Data to Shift/Load | | 6.0V | 9 | 17 | 21 | 25 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | 38 | 100 | 125 | 150 | ns |
| | Shift/Load to Clock | | 4.5V | 12 | 20 | 25 | 30 | ns |
| | | | 6.0V | 9 | 17 | 21 | 25 | ns |
| $t_S$ | Minimum Setup Time | | 2.0V | 35 | 100 | 125 | 150 | ns |
| | Clock Inhibit to Clock | | 4.5V | 11 | 20 | 25 | 30 | ns |
| | | | 6.0V | 9 | 17 | 21 | 25 | ns |
| $t_H$ | Minimum Hold Time Serial | | 2.0V | | 0 | 0 | 0 | ns |
| | Input to Clock or | | 4.5V | | 0 | 0 | 0 | ns |
| | Parallel Data to Shift/Load | | 6.0V | | 0 | 0 | 0 | ns |
| $t_W$ | Minimum Pulse Width, | | 2.0V | 30 | 80 | 100 | 120 | ns |
| | Clock | | 4.5V | 9 | 16 | 20 | 24 | ns |
| | | | 6.0V | 8 | 14 | 18 | 20 | ns |
| $t_{THL}$, $t_{TLH}$ | Maximum Output | | 2.0V | 30 | 75 | 95 | 110 | ns |
| | Rise and Fall Time | | 4.5V | 9 | 15 | 19 | 22 | ns |
| | | | 6.0V | 8 | 13 | 16 | 19 | ns |
| $t_r$, $t_f$ | Maximum Input Rise and | | 2.0V | | 1000 | 1000 | 1000 | ns |
| | Fall Time | | 4.5V | | 500 | 500 | 500 | ns |
| | | | 6.0V | | 400 | 400 | 400 | ns |

## AC Electrical Characteristics (Continued)

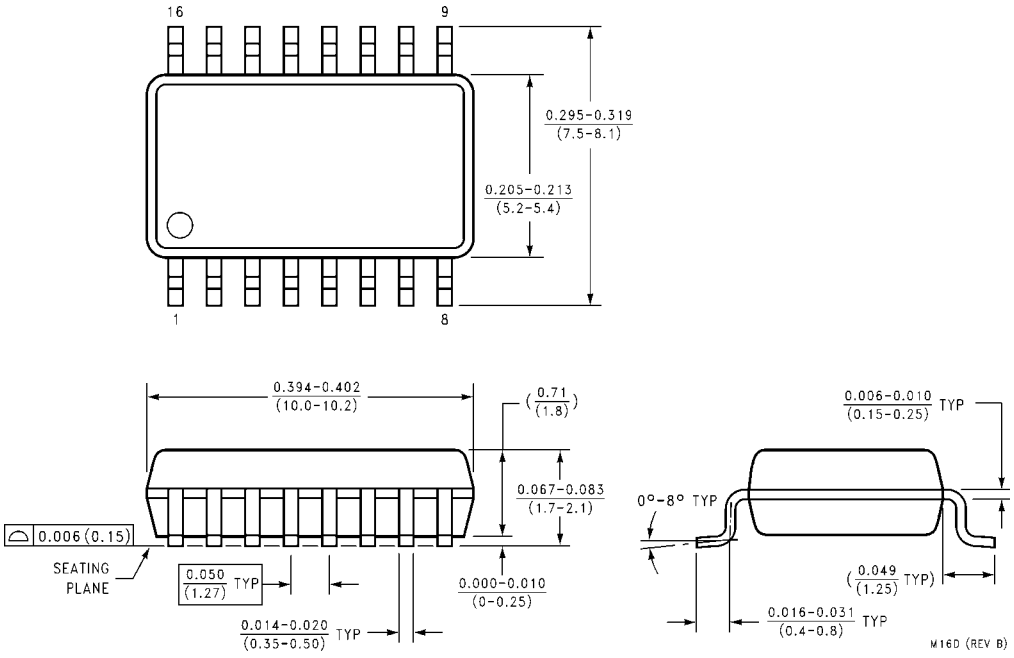
| Symbol | Parameter | Conditions | $V_{CC}$ | $T_A = 25°C$ | $T_A = -40$ to $85°C$ | | $T_A = -55$ to $125°C$ | Units |
|---|---|---|---|---|---|---|---|---|
| | | | | Typ | Guaranteed Limits | | | |
| $C_{PD}$ | Power Dissipation Capacitance (Note 5) | (per package) | | 100 | | | | pF |
| $C_{IN}$ | Maximum Input Capacitance | | | 5 | 10 | 10 | 10 | pF |

**Note 5:** $C_{PD}$ determines the no load dynamic power consumption, $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$, and the no load dynamic current consumption, $I_S = C_{PD} V_{CC} f + I_{CC}$.

## Physical Dimensions inches (millimeters) unless otherwise noted

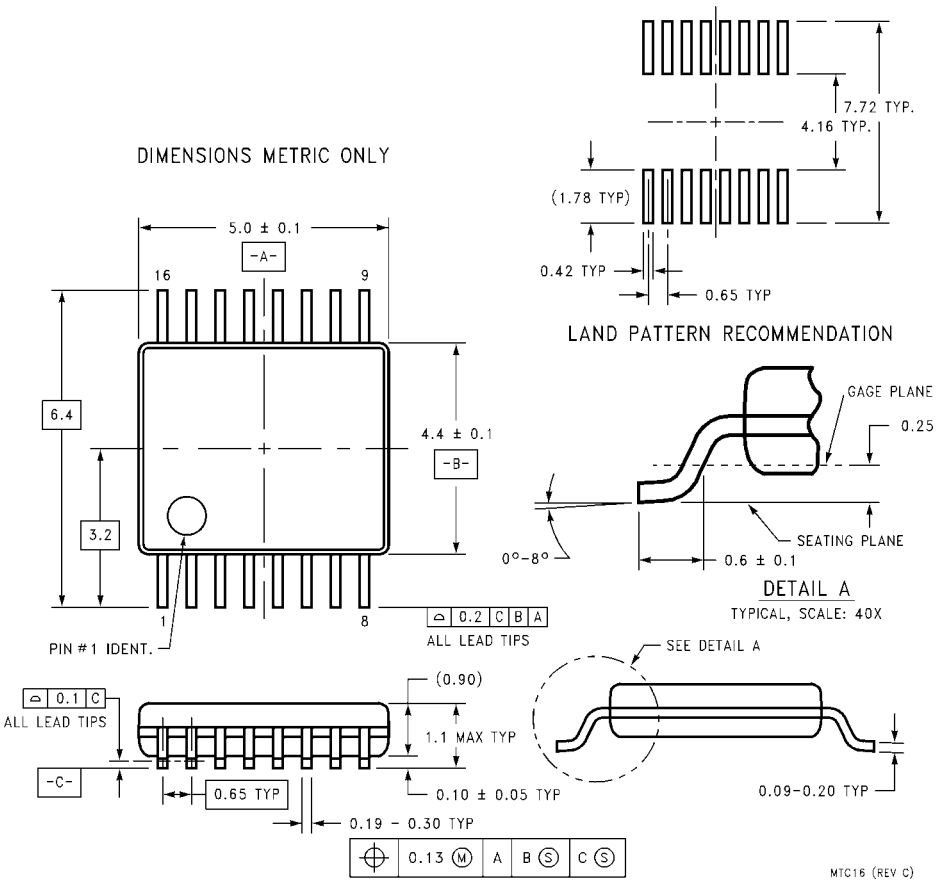



**16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow**
**Package Number M16A**



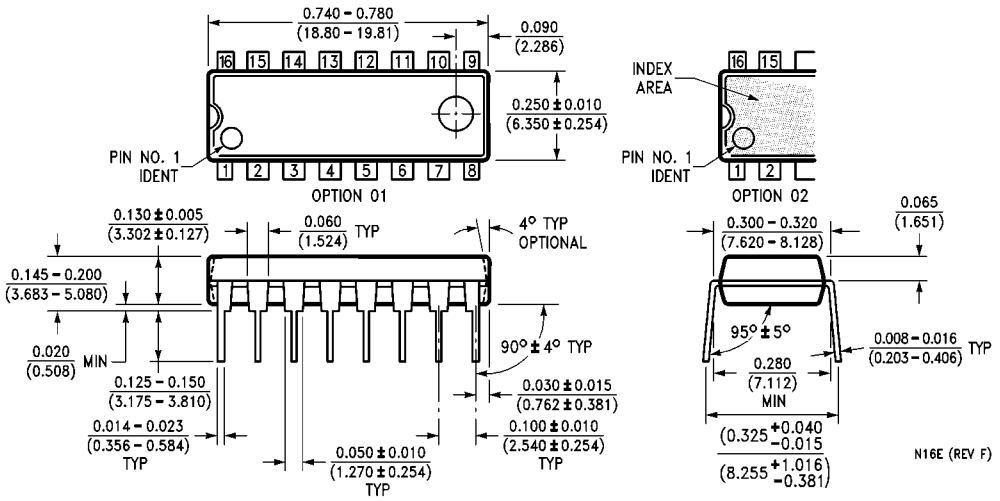

**16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide**
**Package Number M16D**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




**16-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**
**Package Number MTC16**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)




**16-Lead Plastic Dual-In-Line Package (PDIP), MS-001, 0.300" Wide**
**Package N16E**

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